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ABSTRACT

This study is part of a longitudinal research project which investigated the cognitive and social development of rural children (ages 3-5, 6-8, and 9-11 years) in eight states of the U.S.A. This paper, however, reports only the cognitive development of 3- to 5-year-old subjects in rural Nebraska from 1976-1978. The longitudinal sample plus control cohorts added in 1977 and 1978 consisted of 40 3-year-old, 57 4-year-old, and 75 5-year-old children. Six Piagetian tasks from the Nebraska-Wisconsin Cognitive Assessment Battery (NWCAB) were used to collect data: (1) relations task 1 (RT1) - determines how the child seriates with one variable; (2) relations task 2 (RT2) - measures a child's ability to seriate with two variables; (3) classification task 1 (CT1) - assesses the child's ability according to his freely chosen criterion and according to a given specified criterion; (4) number-length 1 (NLT 1) - assesses the child's understanding of the conservation of number; (5) number-length 2 (NLT2) - assesses the child's mastery of conservation of length in the identity format; and (6) number-length 3 (NLT3) - assesses the child's mastery of conservation of length in the equivalent format. These tasks were administered to the three-year longitudinal sample in 1976, 1977, and 1978; to the two-year sample, in 1977 and 1978; and to the control-cohort in 1978 only. Among the results it was found that: (1) NLT2 and NLT3 proved too difficult for this age group (they were excluded from the data analysis); (2) scaled scoring on the NWCAB tasks for 3- to 5-year-old children reflected a progression from preoperational intuitive reasoning to a somewhat higher level of thinking. These findings tentatively support the Piagetian theory of cognitive structural change between the early and middle preoperational periods. (Author/MP)

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A Longitudinal Study* of the Cognitive Development of 3-5 Year Old Rural Children in the State of Nebraska, U.S.A.

by

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for

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A LONGITUDINAL STUDY OF THE COGNITIVE DEVELOPMENT OF 3-5 YEAR OLD RURAL CHILDREN IN THE STATE OF NEBRASKA, U.S.A.

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This study is part of the NC-124: A Life-Span Analysis of Rural Children's Mental and Social Development, in which eight states of the U.S.A. are participating. This paper, however, reports only the cognitive development of 3-5-year-old Ss in rural Nebraska from 1976-1978.

The longitudinal sample plus control cohorts added in 1977 and 1978 consisted of 40 3-year old, 57 4-year old, and 75 5-year old Ss.

Six Piagetian tasks from the Nebraska-Wisconsin Cognitive Assessment Battery: Relations (RT_1, RT_2); Classification (CT_1); and Number-Length (NLT_1, NLT_2, and NLT_3) were individually administered. Scaled scoring reflected a progression from Stage I (not knowing) → Stage IIa, IIb (Transitional) → Stage III (knowing).

NLT_2 and NLT_3 proved too difficult. No sex differences were found. The two longitudinal samples showed significant mean gains from year to year. They progressed from Stage IIa to III on RT_1; and from Stage I to IIb on RT_2, CT_1, and NLT_1. The reasoning was no longer intuitive. Most had moved up by at least one stage. None had regressed. This may be interpreted as structural changes or practice effects. The means of controls and longitudinal samples were found nonsignificant, ruling out practice effects. These findings tentatively support Piagetian theory of cognitive structural change between early and ~~late~~ middle preoperational period.

A Longitudinal Study of the Cognitive Development of 3-5 Year Old Rural Children in the State of Nebraska, U.S.A.

This study is part of the research project, NC-124: A Life-Span Analysis of Rural Children's Mental and Social Development, in which eight midwestern States of the U.S.A. are participating[1]. The purpose is to investigate the cognitive and social development of 3-5, 6-8, and 9-11 year old rural children and the influence of selected environmental factors on this development. This paper, however, reports only the cognitive changes of 3-5 year old children in rural Nebraska over three years, 1976, 1977, and 1978.

Sample

Multistage are sampling techniques[2] meeting the NC-124 guidelines of 'representative randomness', stratified by defined criteria[3] of ruralness, farm-derived income, family intactness, and age were used for selecting the Nebraska sample. Additional cohorts were added to the initial sample pool in the second (1977) and the third year (1978) of data collection as controls for the repeated test effects. The sample design for the 3-5 year old rural Nebraska children is detailed in Table 1.

-Insert Table 1 about here-

Groups 1, 2, and 3 represent the three-year longitudinal sample of the same children tested in 1976, 1977, and 1978 with the same instruments. In 1977, group 4 was added as control-cohort and continued in 1978 as group 5. Thus, groups 4 and 5 form the two-year longitudinal sample. In 1976, group 6 was added as another control to check for the repeated test effects. The composition of the total sample by size, sex, and mean age of different subgroups is described in Table 2.

-Insert Table 2 about here-

Instruments and Data Collection

The Nebraska[4] Wisconsin Cognitive Assessment Battery (NWCAB), one of the six NC-124 instruments, was used for collecting cognitive data. There are three sections in the NWCAB reflecting three selected aspects of cognitive functioning: (1) Relations, (2) Classification, and (3) Number and Length. The NWCAB is comprised of a total of 16 tasks differentially assigned to the three sections. These 16 tasks

are either modified versions of the original tasks devised by Piaget and Inhelder or derived from their theory. Within each section these 16 tasks are arranged in an ascending order of difficulty. The assignment of tasks according to the order of difficulty and age levels reflects Piagetian framework. The first section consists of six Relations tasks (RT_1, RT_2 ... RT_6): two, for the 3-5 year olds; two, for the 6-8 year olds; and two, for the 9-11 year olds. The second section consists of four Classification tasks (CT_1, CT_2 ... CT_4): one, for the 3-5 year olds; two, for the 6-8 year olds; and one, for the 9-11 year olds. The third section consists of six Number and Length tasks (NLT_1, NLT_2 ... NLT_6): three, for the 3-5 year olds; two, for the 6-8 year olds; and one, for the 9-11 year olds. The Testing Kit contains toy-type testing materials for the 16 tasks.

The relevant NWCAB tasks for the 3-5 year old children are summarized briefly:

1. Relations Task #1 (RT_1). The purpose of RT_1, simple seriation, is to determine how the child seriates with one variable (material: seven green cardboard trees (cardboard cones) varying in height progressively by 2 cm from 6.5 cm to 18.5 cm). The score range is 0-6.
2. Relations Task #2 (RT_2). This task, double seriation without transformation, measures a child's ability to seriate with two variables (material: seven cardboard trees of RT_1, and seven brown cardboard pots varying progressively in height from 2 cm to 7 cm. The score range is 0-4.
3. Classification Task #1 (CT_1). The purpose of CT_1 is to assess the child's ability to classify in two ways: 1. sorting according to the child's freely chosen criterion, and 2. sorting according to a given specified criterion (materials: a set of 22, 4x6 cards varying by color--red or blue, by shape--square or circle, and by number--pictures of one or two objects). The score range is 0-4.
4. Number-Length #1 (NLT_1). The purpose of NLT, is to assess cardinal correspondence or the child's understanding of the conservation of number (materials: 10 small same-sized trees (green cardboard cones), 6.5 cm in height; 10 small same sized pots, 2.5 cm x 2.5 cm x 2.5 cm. The score range is 0-8.

5. Number-Length #2 (NLT_2). It assesses the child's mastery of conservation of length in the identity format (materials: one 28 cm long string). The score range is 0-2.
6. Number-Length #3 (NLT_3). It assesses the child's mastery of conservation of length in the equivalent format (materials: two 28 cm long strings). The score range is 0-2.

The NWCAB tasks were individually administered in one testing session of 20-30 minutes, in the child's home or in a mutually agreed upon convenient location. The three-year longitudinal sample was administered these tasks in 1976, 1977, and 1978; the two year longitudinal sample, in 1977 and 1978; and the control-cohort of 1978 was tested in 1978 only.

Standardized procedures for administering, scoring, and coding were followed. Scaled scoring on the NWCAB tasks for the 3-5 year old children reflects a progression from preoperational intuitive reasoning to somewhat higher level of thinking. The following diagram demonstrates this structural change.

-Insert Table 3 about here-

Data Analysis and Results

NLT_2 and NLT_3 proved too difficult for this age group. Therefore, these two tasks were excluded from analysis.

No significant sex differences on any of the tasks were noted. Improvement/change in cognitive performance across time was analyzed in three ways: (1) Subgroup means were expressed as a proportionate percentage of the maximum score for each task and were then plotted across the three years in several line graphs (Figure 1). This graphic representation of changes in means permitted a visual scanning for peaks, or valleys, or upward direction suggesting improvement in cognitive performance; (2) One way ANOVA with pairwise Scheffe follow-ups; and (3) Interpretation of changes in subgroup means in terms of stage-wise progression or regression.

Figure 1 shows the graph of subgroup means expressed as percentage of the maximum score. These lines are neither coincident nor parallel but show a continuous upward direction on all tasks which could be interpreted as improvement on all tasks from 1976 to 1978.

To check if the cognitive performance of the three-year longitudinal sample had significantly improved from 1976 to 1978, the means of groups 1, 2, and 3 were compared: Ho: $\mu_1=\mu_2=\mu_3$.

-Insert Table 4 about here-

As can be seen from Table 4, the RT_1 means: 2.76→4.38→5.35 increased significantly from 1976→1977→1978. One way ANOVA showed the F-ratio to be significant: $F(2,107)=40.07$, $p<.0001$. Further pairwise Scheffé comparisons showed the means of group 1 vs. group 2; group 1 vs. group 3; and group 2 vs. group 3 to be significantly different at .05. This trend holds for RT_2, CT_1, and NLT_1 also.

To check if the cognitive performance of the two-year longitudinal sample had improved from 1977 to 1978 the means of groups 4 and 5 were compared: Ho: $\mu_4=\mu_5$.

Table 5 shows the means, Sds., and F-ratios for this sample.

-Insert Table 5 about here-

As can be seen from Table 5, except for RT_2, the cognitive performance had significantly improved from 1977 to 1978.

Another way of looking at these mean gains is to examine the stage-wise progression from 1976 to 1978. On RT_1 the children had progressed from Stage IIa in 1976 to Stage III in 1978; from Stage I to Stage IIb on RT_2, CT_1, and NLT_1. Children were encouraged to give reasons or logical justification for their answers. In 1976 most of their responses indicated intuitive reasoning but by 1978 the same children had advanced to expressing somewhat more coherent and logical reasoning to the same tasks. Most had moved up by at least one stage. None had regressed. Could this change -- increase in mean scores, and transition to a higher stage from 1976 to 1978, be due to cognitive structural changes or due to repeated test effects? To check for the repeated test effects the means of group 2 vs. group 4

(control) in 1977; and means of groups 3 vs. group 5 (control) vs. group 6 (control) in 1978 were compared: Ho: $\mu_2=\mu_4$; Ho: $\mu_3=\mu_5=\mu_6$. The mean differences were non-significant except for RT_2 in 1978. Thus practice effects may be ruled out in favor of cognitive structural changes on RT_1, CT_1 and NLT_1.

Conclusion

Cross sectional studies reported in research literature have provided substantive support for the Piagetian theory that changes in cognitive structure do occur during the preoperational period of development. Longitudinal studies, however, may provide additional and even more convincing evidence for the intra structural changes over time in the same individuals. This three-year longitudinal study of the 3-5 year old children of similar rural background provides additional support for the Piagetian theory that changes in cognitive performance may also reflect qualitative structural changes between early and later preoperational period of cognitive functioning. The implications of these cognitive developmental changes are important for any program planning for the preschool children of 3-5 years of age.

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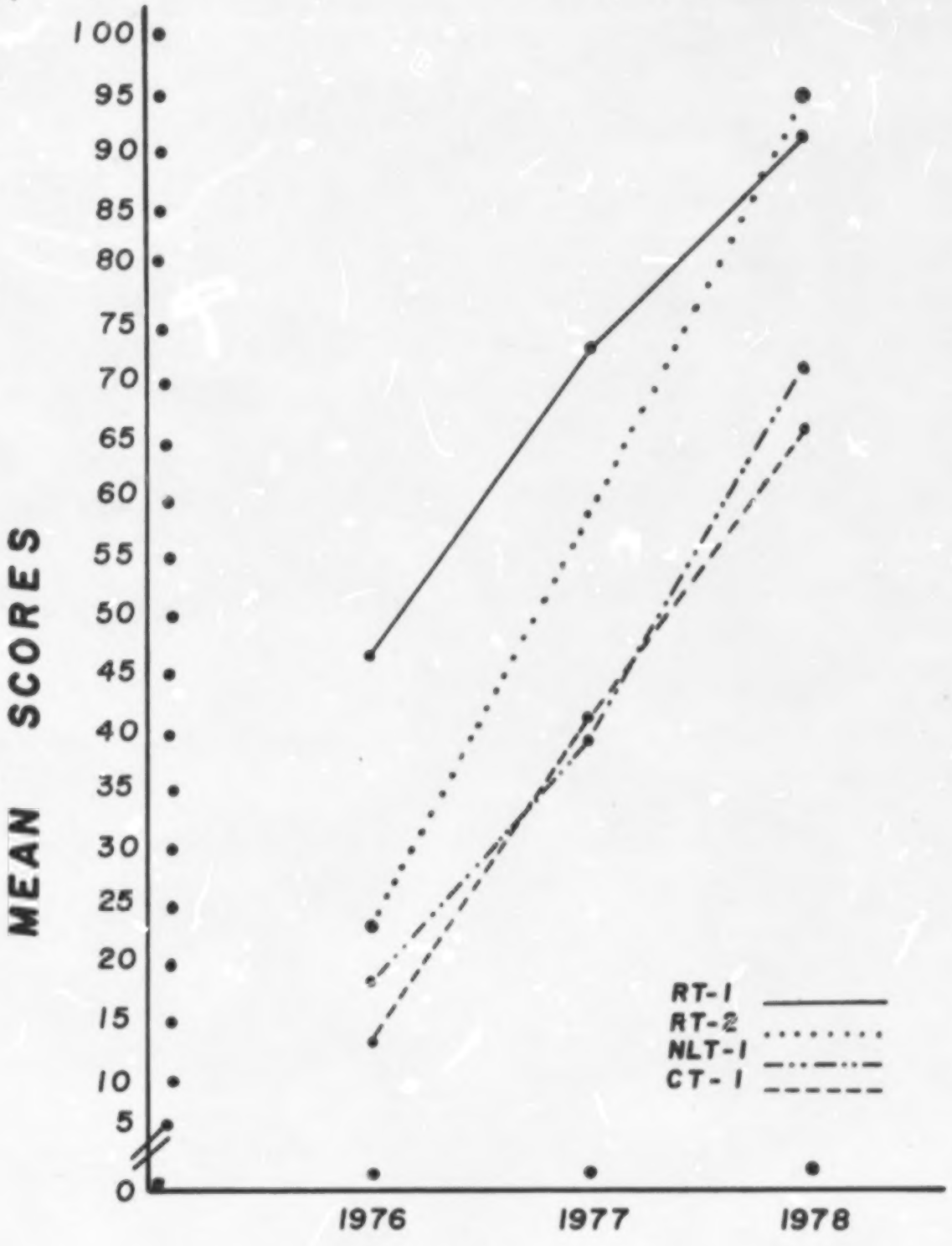
FOOTNOTES

1. This study used the same sample and the same cognitive data as utilized for the NC-124: A Life Span Analysis of Rural Children's Mental and Social Development. This is a regional project in which several mid-western states of the U.S.A. are cooperating. The participating states are: Illinois, Indiana, Iowa, Kansas, Michigan, Nebraska, Wisconsin, and Missouri. Support for the NC-124 has been provided by the Experiment Stations of their respective State Universities.
2. Dr. H. Whitt, Director Bureau of Sociological Research, University of Nebraska-Lincoln, drew the Nebraska sample in accordance with the NC-124 guidelines.
3. The NC-124 Screening Form developed at Iowa State was used. The eligibility criteria included such things as family intactness, continuous residence on a farm of ten acres or more, deriving some income from farm, having a child of appropriate age, etc.
4. The NMCAB was developed for the NC-124 under the direction of Violet Kalyan-Masih, Ph.D., University of Nebraska-Lincoln and William Marshall, Ph.D., University of Wisconsin-Madison. Information about the NMCAB Manual and Testing Kit may be obtained from W. Marshall.



3-5 YEAR OLD SUBJECTS

Table 1

The NC-124 Nebraska Sample of the 3-5 Year-old Children

1976	1977	1978
3(N=40) Group 1	4(N=36) Group 2	5(N=35) Group 3
	4(N=21) Group 4	5(N=20) Group 5
		5(N=20) Group 6

(Underlined figures indicate mean age; arrows show continuity of subgroups; and the subgroups are designated numerically to facilitate description and analysis).

Table 2

Size, Sex, and Mean Age in Months of Each Subgroup in the Sample

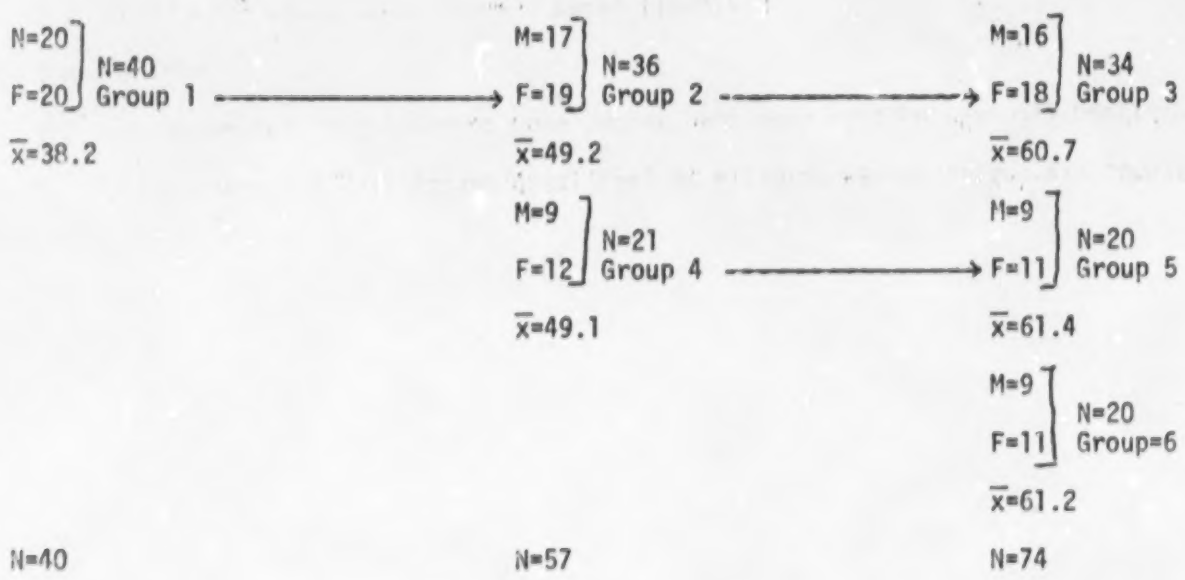


Table 3

Stage Interpretation of Scaled Scoring on the NWCAB Tasks for the 3-5 Year-old Children

Task	Score Range	Stage I (Not Knowing)	Stage IIa (Transitional)	Stage IIb (Transitional)	Stage III (Knowing)
RT_1	0-6	0-2	3-4	5	6
RT_2	0-4	0	1-2	3	4
CT_1	0-4	0	1-2	3	4
NLT_1	0-8	0-1	2	3-6	7-8

Table 4

Means, Sds., and F-ratios for the Three-year Longitudinal Sample

	1976 N=40 Group 1 $\bar{x}$ sd	1977 N=36 Group 2 $\bar{x}$ sd	1978 N=34 Group 3 $\bar{x}$ sd	df	F-ratio	Probability
RT_1	2.76(1.45)	4.38(1.27)	5.35(0.98)	2,107	40.07	.0001
RT_2*	0.92(0.97)	2.33(1.41)	3.75(0.59)	2,57	39.15	.01
CT_1	0.50(0.79)	1.64(1.08)	2.65(0.87)	2,107	50.68	.0001
NLT_1	1.40(1.06)	3.00(2.32)	5.68(2.79)	2,107	37.12	.0001

*For RT_2 N=12 in 1976; N=18 in 1977; and N=28 in 1978. Only those children who passed RT_1 were given RT_2.

Table 5

Means, Sds., and F-ratios for the Two-year Longitudinal Sample

	1977 N=21 Group 4		1978 N=20 Group 5				
	$\bar{x}$	sd	$\bar{x}$	sd	df	F-ratio	Probability
RT_1	4.02	1.35	5.23	1.03	1,39	10.21	.003
RT_2	2.57	1.40	2.88	1.32	1,22	0.27	.61
CT_1	1.36	1.15	2.20	1.30	1,39	4.83	.03
NLT_1	2.38	2.22	5.10	2.69	1,39	12.48	.001

*For RT_2 N=7 in 1977, and N=17 in 1978. Only those who passed RT_1 were given RT_2.